(12) UK Patent Application (19) GB (11) 2 058 577 A

(21) Application No 7933105
(22) Date of filing 25 Sep 1979
(43) Application published 15 Apr 1981
(51) INT CL³ A62B 7/10
(52) Domestic classification A5T CK
(56) Documents cited 2032284 A
(58) Field of search A5T
(71) Applicants Racal Safety Limited, Beresford Avenue, Wembley, Middlesex HA0 1RU
(72) Inventor Joseph Raymond Hilton
(74) Agents A. A. Thornton & Co., Northumberland House, 303-306 High Holborn, London, WC1V 7LE

(54) **Improvements in and relating to breathing apparatus**

(57) The present invention relates to improvements in breathing apparatus of the type comprising a housing for mounting on a wearer to cover at least the nose and/or mouth of the wearer, and which may be a half face mask, a full face mask or a helmet.

The housing 11 is sealed to the wearer to define a substantially closed chamber surrounding the wearer's nose and mouth. Filtered air is supplied to the chamber by a pump and air exits from the chamber through an exhale valve 19 arranged to maintain a positive pressure within the chamber. To reduce the amount of air flowing through the filter, a valve 61 is provided in the path of air flowing to the chamber and is controlled by a detector 20, for example a pressure detector, which detects exhalation by the wearer and causes operation of the valve to at least reduce the flow of air during at least part of the exhalation part of the breathing cycle of the wearer.

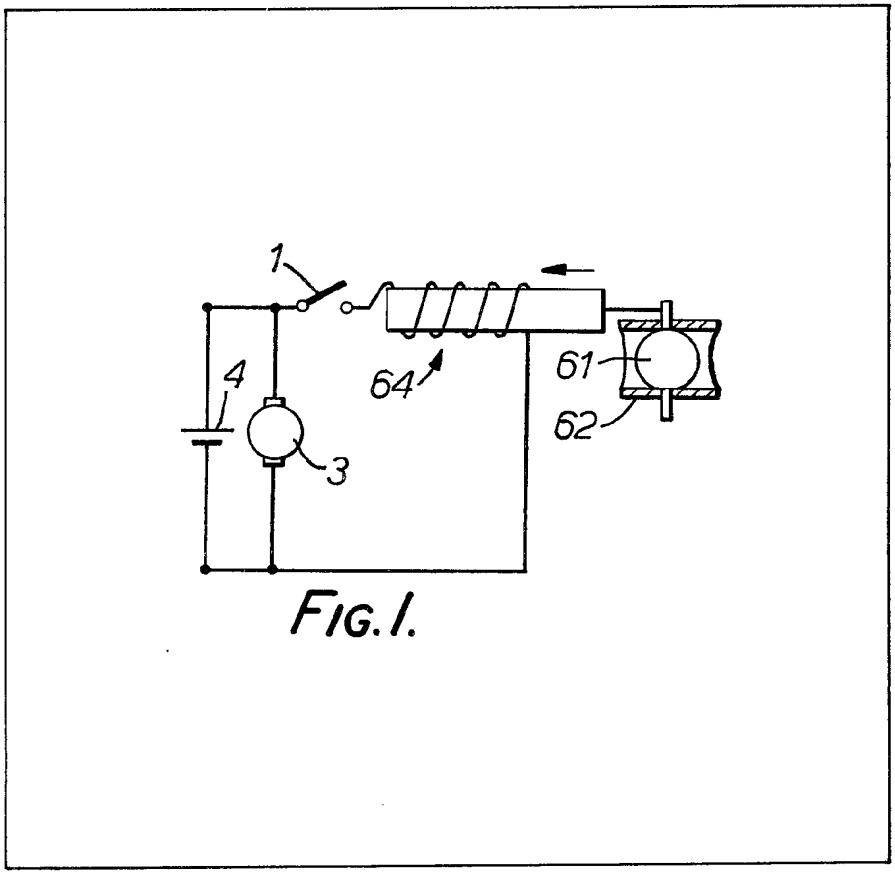

FIG. 1.

GB 2 058 577 A

1/1

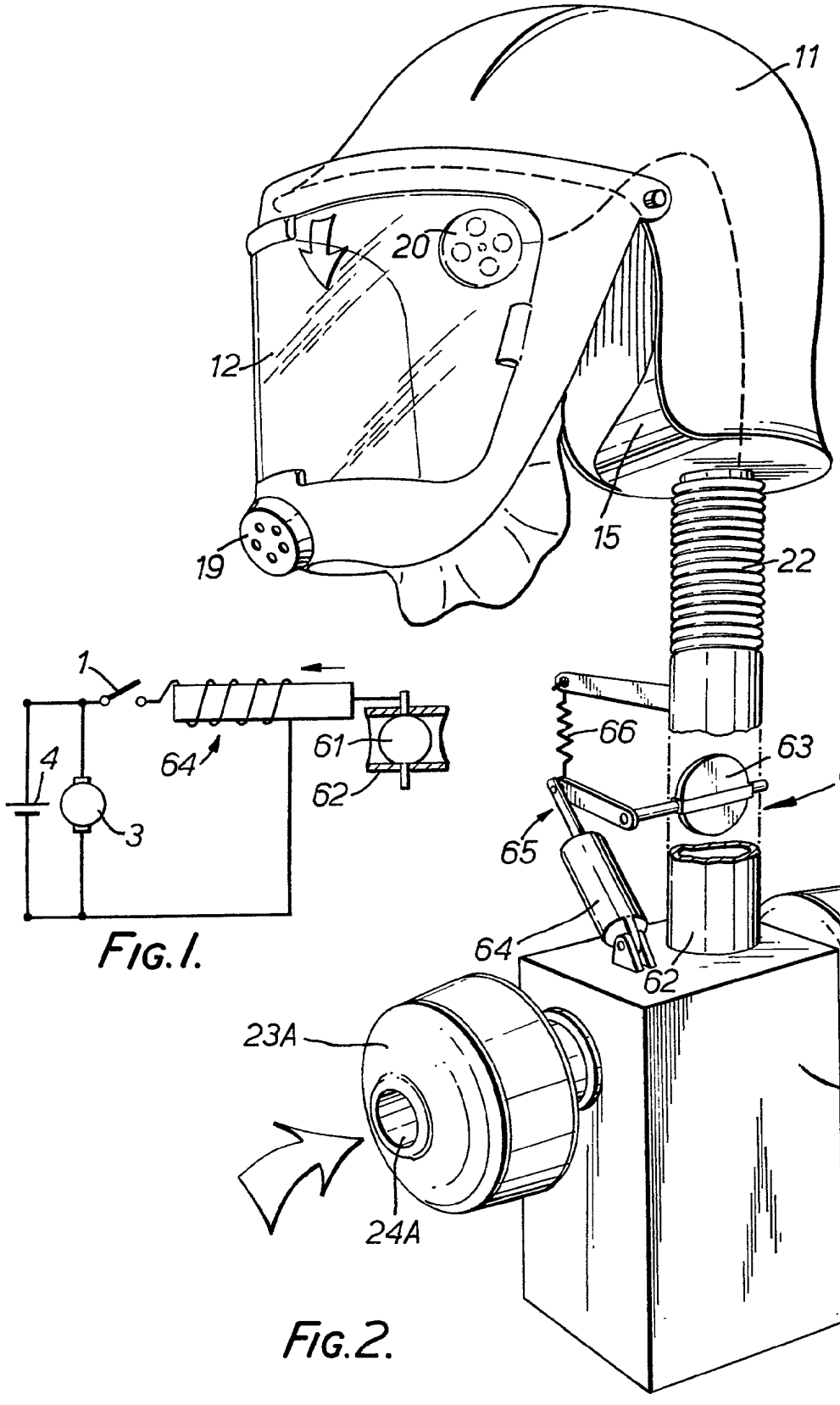

FIG. 1.

FIG. 2.

SPECIFICATION

Improvements in and relating to breathing apparatus

The present invention relates to breathing apparatus, more particularly but not exclusively of the type known as powered respirators or power-assisted respirators in which a pump supplies filtered air to the face of the wearer to ensure a supply of clean breathable air in a dusty or otherwise contaminated environment.

Specifically the invention relates to an improvement in the breathing apparatus described in copending applications nos. 38974/78, 42128/78 and 49149/78, and a simultaneously filed application claiming priority of the above three applications.

These applications are concerned with the problem of increasing the life of the filters used in such breathing apparatus to remove the contaminant in the atmosphere surrounding the wearer. In these applications it is proposed to improve the filter life by reducing the average rate of flow of air through the filter by stopping or reducing the speed of the air pump for at least part of the exhale part of the breathing cycle of the wearer. This is effected by providing in the breathing apparatus detector means for detecting exhalation by the wearer, which detector means are connected to control the pump.

However it has been found that the inertia of some pumps used in such breathing apparatus is too high for the pump to respond within the period that the exhale detector is activated.

According to the present invention there is provided breathing apparatus comprising a housing for mounting on the wearer to cover at least the nose and/or the mouth of the wearer and adapted to define with the wearer a substantially closed chamber surrounding the wearer's nose and/or mouth, outlet valve means for permitting air to flow from said chamber, pump means for supplying air to said chamber, filter means arranged for filtering air supply by said pump means to said chamber, control means for controlling flow of air through said filter means and flowing to said chamber, valve means for controlling flow of air to said chamber, and detector means for detecting exhalation by the wearer and connected to said valve means for at least reducing flow of air through said filter means and flowing to said chamber during at least part of each exhale part of the breathing cycle of the wearer.

The valve means may be operative either to reduce the flow of air or to substantially stop flow of air and may be provided at any suitable point in the path of air from the inlet to the breathing apparatus to the chamber. For example the valve means may be provided at the outlet of the pump means. Preferably the valve means has the form of a disc pivoted about its diameter and arranged on a diameter of a tube. In its open position, the disc is in the plane of the diameter and containing the axis of the tube and in its closed position the disc may be in a plane perpendicular to the axis of the tube or in an intermediate position inclined thereto. The advantage of such a valve is that as it is closed, the pressure of the air on the two halves of the disc is balanced so that minimal force is required to close it.

The valve may be operated by a solenoid connected in series with a switch operated by the detector means across the power supply to the pump means, for example a DC battery.

The detector means may be as described in the above referred to applications, as may the housing and arrangement of filter means.

It will be appreciated that this form of control of the air flowing through the breathing apparatus also has the advantage of reducing the power required for the pump means because, when the valve is in its closed or partly closed condition, the fan is stalled or will rotate at a lower speed thus requiring less power.

An embodiment according to the present invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

Figure 1 is a diagrammatic circuit for use in controlling an embodiment of breathing apparatus according to the present invention; and

Figure 2 is a perspective view of an embodiment of breathing apparatus according to the present invention.

The breathing apparatus shown in Figure 2 has the form of a powered respirator helmet similar to that shown in Figure 4 of the simultaneously filed application referred to above and reference should be made to that application and comprises a shell 11 which extends over the top, rear and sides of the head and is provided inwardly with a supporting harness (not shown) by which it bears on the wearer's head. At the front, the helmet is closed by a transparent visor 12 and the helmet is sealed to the wearer's head around the head and down the sides of the face and under the chin.

Air is supplied to the helmet through a flexible trunking 22 which is connected to a housing 15 at the rear of the helmet, the housing 15 opening into a space above the head of the wearer which is in communication with the wearer's face. Trunking 22 is connected to a power pack 21 in which the pump, e.g. a fan and DC motor, and filters are provided, as shown the filters being provided as replaceable canisters 23*a* provided with inlets 24*a*.

As in the breathing apparatus described in the above referred to applications, the helmet is provided with an exhale valve 19 and a pressure detector 20 for detecting exhalation by the wearer.

As in the above referred to applications, the detector 20 may be associated with a switch which, in this embodiment is connected to actuate a valve 61.

The valve 61 is, as shown, mounted in a tubular casing 62 connected between the outlet of the unit 21 and the trunking 22. The valve 61 comprises a circular disc 63 pivotally mounted in the casing 62 for rotation about a diameter of the casing 62 and a

diameter of the disc 63. In its open position, the disc 63 extends, as shown in Figure 2, in the plane of the axis of the casing 62 and in its closed position the disc 63 extends perpendicular to the axis of the casing 62 to close the passage in the casing, or the disc 63 may be in an intermediate inclined position to partially close the passage in the casing 62.

The valve may be operated, for example as shown by a solenoid 64 and a system of levers 65. The solenoid 64 may, as shown in Figure 1, be connected in series with the switch 1 across the power supply, for example a DC battery 4 which supplies power to the pump 3 in the unit 21.

As in the above referred to applications, the exhale valve 19 is intended to maintain a positive pressure within the chamber extending over the wearer's nose and mouth and defined by the shell 11, visor 12, sealing means and the wearer. This positive pressure may for example be 10mm w.g. above atmospheric pressure. The exhale detector 20 is also as described in the above referred to applications and is arranged to be actuated by a pressure within the chamber above that set by the exhale valve, for example 15mm w.g.

In operation, during inhalation, the pump 3 runs normally and delivers the required amount of air, for example 160 litres per minute, to the wearer who largely inhales it, any surplus air escaping through the exhale valve. At the moment of exhalation the build up of pressure within the chamber causes the diaphragm of the pressure detector 20 to act on the switch 1 which connects the solenoid 64 to the battery 4. The solenoid is thereby energised to move the valve 61 to a position closing the passage in casing 62 or preferably to an intermediate position reducing the section of the passage in casing 62 and therefore the rate of flow of air to the helmet to a level which is just sufficient to wash the carbon dioxide in the exhale out of the chamber. Towards the end of exhalation, when the pressure in the chamber has dropped to the pre-set level, the switch 1 is returned to its original position and the solenoid 64 is de-energised. The valve is returned to its original position by a spring 66 which, as shown acts on the lever system 65. The spring may alternatively act on the solenoid 64.

It will be appreciated that the valve 61 may have other forms than that shown, the requirement merely being that it is capable of at least in part reducing the flow of air to the helmet. It may also be actuated in ways other than that shown in Figures 1 and 2 and, with other arrangements of the parts of the breathing apparatus, may be alternatively positioned upstream of the pump or upstream of the filter means.

It will be appreciated that the exhale detector 20 may take any of the forms described in the above referred to applications and that the invention of this application is equally applicable to other forms of powered breathing apparatus such for example as any of the embodiments described in the above referred to applications. For example in the helmet illustrated in Figure 2 of the application filed simultaneously herewith, a valve could be provided either at the inlet to the pump 16 or at the outlet to the pump, upstream of the filter means 18, the valve being actuated by the detector 20, for example as herein described.

In the embodiment of Figure 3 of the application filed simultaneously herewith, the valve could be positioned at the outlet of unit 21, as shown in Figure 2 herewith. Similarly in the embodiments of Figures 5 and 6 of the application filed simultaneously herewith, the valve may again be placed at the outlet of the unit 21. In the embodiment of Figures 7 and 8 of the application filed simultaneously herewith, a valve could be arranged upstream of the pump 59, for example in the area of the inlet 56.

The above described breathing apparatus have all the advantages of the breathing apparatus described in the application filed simultaneously herewith and in addition have the advantage that it does not depend for its control on the pump but on a valve which can easily be designed to have minimum inertia.

CLAIMS

1. Breathing apparatus comprising a housing for mounting on the wearer to cover at least the nose and/or the mouth of the wearer and adapted to define with the wearer a substantially closed chamber surrounding the wearer's nose and/or mouth, outlet valve means for permitting air to flow from said chamber, pump means for supplying air to said chamber, filter means arranged for filtering air supplied by said pump means to said chamber, valve means for controlling flow of air through said filter means and flowing to said chamber, and detector means for detecting exhalation by the wearer and connected to control means for said valve means for operating said valve means to at least reducing flow of air through said filter means and flowing to said chamber during at least part of each exhale part of the breathing cycle of the wearer.

2. Apparatus as claimed in claim 1, wherein said detector means comprises a pressure detector for detecting an increase in pressure in said chamber resulting from exhalation by the wearer.

3. Apparatus as claimed in claim 2, wherein said detector means is arranged to change the state of switch means on detection of a pressure above a preset level and to maintain said changed state of said switch means until the pressure drops below said pre-set level.

4. Apparatus as claimed in claim 3, wherein said switch means is connected in the circuit of said valve control means.

5. Apparatus as claimed in any one of claims 2 to 4, wherein said pressure detector comprises a diaphragm subject on one face to the pressure within said chamber and subject on the other face to atmospheric pressure, said diaphragm being biased so as to move when the pressure in said chamber is above atmospheric pressure by a pre-set amount so as to maintain a positive pressure within said chamber.

6. Apparatus as claimed in any one of the preceding claims, wherein said outlet valve means comprises a one-way valve means which is operable to permit air to flow therethrough from said chamber so as to maintain a positive pressure in said

chamber.

7. Apparatus as claimed in any one of the preceding claims, wherein said filter means is arranged to filter air as it flows from said pump means to said chamber.

8. Apparatus as claimed in any one of claims 1 to 7, wherein said filter means is arranged to filter air flowing to said pump means.

9. Apparatus as claimed in any one of the preceding claims, wherein said filter means is arranged to be removable from the apparatus for replacement purposes.

10. Apparatus as claimed in any one of the preceding claims, wherein said housing is adapted to cover the nose and mouth of the wearer and to be peripherally sealed to the wearer's face.

11. Apparatus as claimed in claim 10, wherein said housing is adapted to cover the face of the wearer and to be peripherally sealed thereto.

12. Apparatus as claimed in any one of the preceding claims, wherein said housing covers the head of the wearer and includes a visor extending over the face of the wearer, seal means being provided for sealing said housing to said wearer's head to define said chamber.

13. Apparatus as claimed in any one of the preceding claims, wherein said valve means comprises a tubular valve body defining a passage through which air flows to said chamber, a disc mounted for pivotal movement about a diameter thereof in said passage for pivotal movement about a diameter of said passage between an open position in which said disc extends in a plane containing the axis of said passage and a closed position in which said disc extends in a plane perpendicular to said axis of said passage or inclined thereto.

14. Apparatus as claimed in any one of the preceding claims, wherein said valve means is provided downstream of said pump means.

15. Apparatus as claimed in any one of claims 1 to 13, wherein said valve means is provided upstream of said pump means.

16. Apparatus as claimed in any one of claims 1 to 13, wherein said valve means is provided downstream of said filter means.

17. Apparatus as claimed in any one of claims 1 to 13, wherein said valve means is provided upstream of said filter means.

18. Breathing apparatus substantially as herein described with reference to the accompanying drawings.

Printed for Her Majesty's Stationery Office by The Tweeddale Press Ltd., Berwick-upon-Tweed, 1981.
Published at the Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.